



ENVIRONMENTAL SERVICES INCORPORATED

**PHASE II – SUBSURFACE PRODUCT RECOVERY
SYSTEM DESIGN**

**FOR THE
COMMONWEALTH OIL AND REFINING COMPANY
PEÑUELAS, PUERTO RICO**

DSM PROJECT NO. 1125-01

AUGUST 14, 1998

PREPARED BY:

DSM ENVIRONMENTAL SERVICES, INC.



ENVIRONMENTAL SERVICES INC.

August 14, 1998

Mr. Richard Krauser
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region II
HAZARDOUS WASTE FACILITY BRANCH
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: Commonwealth Oil Refining Company
Phase II: Subsurface Product Delineation and Formation Evaluation Work Plan -
Phase II - Subsurface Product Recovery System Design
EPA I. D. PRD091017228

Dear Mr. Krauser:

DSM Environmental Services, Inc. (DSM), on behalf of the Commonwealth Oil Refining Company (CORCO) presents the following Phase II – Product Recovery System Design. This design document describes the installation and initial operation of the recovery system that will recover the hydrocarbon product that is located beneath the CORCO facility in Peñuelas, Puerto Rico. This work was performed in accordance with EPA correspondence of April 24, 1996. This design document completes the *Phase II: Subsurface Product Delineation and Formation Evaluation Work Plan* as approved by EPA.

This design is presented for your review and comment. In the schedule for the project we have assumed that the project will start on December 1, 1998 and be completed in May of 2000. In order to accomplish the work within this time frame CORCO would appreciate your comments by October 1, 1998. In the event that CORCO does not receive comments by that time it is their intent to pursue the project according to the schedule.

In the meantime, if you have any questions or comments please call us at (281) 870 – 8676.

Sincerely,
DSM Environmental Services, Inc.

Joe H. Rafferty
President

Attachments

cc: Mr. Israel Torres - PREQB
Mr. Dale Byars - CORCO
Mr. Roberto Gratacos - CORCO
Mr. Edert Ortiz - CORCO
DSM File: 1125-01/ 22.0

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FOR THE

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**DSM ENVIRONMENTAL SERVICES, INC.
1830 SOUTH KIRKWOOD, SUITE 201A
HOUSTON, TEXAS 77077**

(281) 870-8676

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1. INTRODUCTION

Pursuant to the schedule of tasks presented to the U.S. Environmental Protection Agency on December 19, 1997 and on behalf of Commonwealth Oil Refining Company (CORCO), DSM Environmental Services, Inc. (DSM) presents this PHASE II – SUBSURFACE PRODUCT RECOVERY SYSTEM DESIGN Report as required by the *Phase II – Subsurface Product Delineation and Formation Evaluation Work Plan*. This recovery system is designed to recover the hydrocarbon product that has been found on the ground water within the CORCO facility, located in Peñuelas, Puerto Rico. This recovery system design is the final step, *Step #4*, of the *Phase II – Subsurface Product Delineation and Formation Evaluation Work Plan*. The installation and operation of this product recovery system will replace all of the interim recovery efforts that have been in progress at the CORCO Facility for the past few years.

Previous studies by DSM and others have identified the presence of hydrocarbon product in the subsurface. This hydrocarbon product is contained within the Ponce Limestone Formation in a lens-shaped mass that is floating on the ground water table. The entire lens is located beneath the facility, north of Highway 127. The objective of this recovery system is to recover as much of the subsurface product from the water table as possible without removing ground water. Computer simulations indicate that it should be possible to recover this product lens using a conventional product recovery system that skims only the product from the ground water table.

The Product Recovery System consists of 35 new and 9 existing recovery wells distributed across the area of the product plume for a total of 44 recovery wells. These wells will be connected to a conveyance system that transfers the recovered product to a central collection tank. The product will be accumulated and stored in the storage tank until a volume, sufficient for barge or marine vessel transport and sale, has been collected.

2. HYDROGEOLOGY OF THE CORCO FACILITY

The portion of the facility that is underlain by the product plume is located on a surface exposure of the Ponce Limestone. The Ponce Limestone in the facility area is a Miocene age, back bay, and/or back reef deposit that is composed primarily of calcareous clay with filled tidal channels, buried tidal flats, small reef structures, isolated corals, numerous mollusk fossils, and some solution and/or structural cavities.

The entire area has been densely faulted during tectonic uplift. One fault in the northeast portion of the facility, identified on the USGS “*Geologic Map of the Peñuelas and Punta Cuchara Quadrangles*” (Krushensky, and Monroe, 1978), has a surface exposure in the southwestern part of the facility in the area of wells PD-10 and PT-3. (**Figure 1: Location of Existing Monitoring Wells and Proposed Recovery Wells, Recovery Well Locations**) The fault is oriented north-northeast - south-southwest and dips very steeply to the northwest. Vertical displacement appears to be small. Wells PT-3 and PT-

2 are screened in this fault zone and a line drawn between them represents the fault trace through the facility. Faulting exposed in outcrops of the Ponce Limestone along Highway 2, east of the facility, indicates that the north-northeast - south-southwest direction is the primary fault orientation and the dips are very steep to the west-northwest, similar to the fault orientation in the facility. Other parallel and offset faults and joints are evident within the facility boundaries as well as outside of the facility. Vertical movement of water through the formation appears to be primarily along secondary permeability features such as joints and faults.

Other secondary permeability development, in the form of cavities, has been observed along the fault and joint exposures and in massive outcrops within the facility and outside of the facility. These cavities were formed by solutioning of the limestone or during the deposition of the clays and subsequent submarine landslides. The cavities that have been observed are widely spaced and do not appear to be connected in any sort of continuous, cave-like formation. They do not contain ground water if they are above the water table. The solution cavities associated with the fault structures in the Ponce Limestone appear to be formed by water solutioning of the limestone and follow fault orientations.

Sustained pumping rates for water wells in the Ponce Limestone are generally 1 to 30 gallons per minute (gpm), although the higher volume is attributed to wells that are screened in both the Tallaboa River alluvium and the Ponce limestone (Grossman, et.al., 1972). Outcrops of the Ponce Limestone in the facility and surrounding areas look like a typical, back bay or back-of-reef, marine, calcareous clay formation wherein the primary (horizontal) permeability should be in the range of 1×10^{-7} to 1×10^{-10} cm/sec. Natural, vertical permeability in this type of formation is typically two to three orders of magnitude less than the primary permeability, except along vertical, secondary features such as faults and joints (Driscoll, 1987). Small reef structures, rubble layers, and some more granular facies in the Ponce Limestone may locally increase the hydraulic conductivity of the formation somewhat, but they are not continuous throughout the formation. Calcareous, marine clay deposits such as those found in the facility and in surrounding areas typically would not produce water in excess of 1 to 5 gpm except from secondary permeability features such as fractures or voids.

Horizontal movement of product through the Ponce Limestone within the CORCO Facility appears to be controlled by the occurrence of a marine clay layer in the sediments to the south of Highway 127. This clay layer butts against the limestone at approximately the same elevation as the water table and prevents the migration of hydrocarbon product to the south of the highway (DSM, 1998). This marine clay acts as a confining or semi-confining layer for the ground water south of the highway, whereas the ground water north of the highway is unconfined. In the facility area, north of Highway 127, the ground water movement appears to be generally to the west-southwest.

3. RECOVERY WELL LOCATIONS

The results presented in the Phase II – Subsurface Product Recovery Simulation Report (DSM, 1998) indicate that approximately 35 recovery wells, evenly distributed over the

area of the product plume will effect the most efficient recovery of product. Therefore, 35 new wells have been located across the facility, where there is product in the subsurface. In addition to the 35 new wells, nine (9) existing, four-inch diameter wells will be incorporated into the recovery system. Where possible, the new wells will be located near existing monitoring wells so that the performance of the recovery wells can be determined.

In locating the wells, deference was given to the operating portions of the facility. For example, wells could not be located within the containment structures of operating tanks because of the fire hazard. Other locations were selected to accommodate overhead or underground pipes and utilities. The location of each well was field checked for accessibility. These well locations are shown on **Figure 1: Location of Existing Monitoring Wells and Proposed Recovery Wells, Recovery Well Locations.**

4. RECOVERY WELL DESIGN

Previous hydraulic conductivity tests indicate that the hydraulic conductivity of the Ponce Limestone is small, except in areas where voids are encountered (DSM, 1998). Therefore, to increase the potential for recovery of product from the formation, large diameter wells will be installed. A large diameter well is more efficient in capturing the product into it because it presents a larger area of well screen to the formation. The well size limitation is a function of the depths that need to be drilled, the size of the drilling rig necessary to install a given diameter well, and the accessibility of the well locations to the drilling equipment. At the CORCO Facility the wells range in depth from about 10 meters (33 feet) up to about 70 meters (230 feet) and access to the sites where wells will be installed is limited to truck mounted equipment. Considering the access restriction to the drilling sites, the largest well that can be installed is a six-inch (6") diameter well, in a twelve-inch (12") diameter boring. With proper sand packing of the screened area the effective diameter of the well will be 12 inches.

Each of the new wells that are installed for this recovery system will be six inches in diameter. However, there are some existing, four-inch diameter wells that have product in them that will be incorporated into the system

4.1. WELL MATERIALS

Previous experience with well installations at the CORCO Facility indicates that a combination of heavy duty PVC casing and stainless steel, continuous slot well screens results in efficient wells that remain useable for long periods of time. The primary criterion to prevent well collapse when using PVC casing is the thickness of the PVC. Schedule 80 PVC has proven strong enough to resist the formation pressures that lead to collapse of the casing. Some of the existing wells that will be used in the Recovery System are constructed with Schedule 40 PVC casing, but there are no plans to replace them unless they become unusable.

Each of the new recovery wells will consist of Schedule 80, PVC, flush threaded casing attached to a stainless steel, continuous slot well screen. The screen will have a solid, stainless steel sump, two feet long, welded to the bottom. A screen slot size of 0.020 inches (20 slot), with a proper gravel pack retards infiltration of the formation into the screen to an acceptable level, based on previous experience. The gravel pack will consist of a 20/40 size, washed, well-rounded, silica sand. Bentonite pellets will be placed above the sand pack to function as a seal to prevent upward or downward migration of fluids within the well annulus. A minimum ratio of five percent, by volume, bentonite will be added to a Type I, Portland cement to make up the grout that will be used to fill the annulus of the well from the top of the bentonite seal to the surface.

4.2. WELL CONSTRUCTION

At each new recovery well site, a 12-inch diameter boring will be drilled using an air-rotary drilling rig. The boring will be advanced to a minimum depth of 27 feet below the level of the product. The boring will be reamed and cleaned to assure that no formation collapse will occur during construction of the well.

In each boring a well will be constructed that consists of six-inch diameter, Schedule 80 PVC, flush threaded casing that is attached to a six-inch diameter, stainless steel, 20 slot, continuous slot well screen. The casing and screen will be centered in the well by stainless steel centralizers. The well screen will have a two-foot long, solid, stainless steel, silt sump welded to the bottom of it. Each well screen will be 30 feet long and will be set in the well such that approximately five feet of screen will extend above the product surface. The five feet of exposed screen should be sufficient to allow for fluctuation of the product surface without the top of the screen being submerged below the ground water surface. Measured fluctuations in the ground water elevation are generally less than one foot.

Around each screen a sand pack will be tremied into place. The sand pack will consist of a 20/40 size, washed, well-rounded, silica sand. The sand pack will extend from the bottom of the boring to approximately two feet above the screen to retard penetration of the gravel pack by the bentonite plug. Above the sand pack a one-foot thick bentonite seal will be placed by tremieing bentonite pellets into the boring. The bentonite pellets will be hydrated with potable tap water. A bentonite/cement grout will then be tremied into the well from the top of the bentonite seal to the surface of the well.

4.3. WELL HEAD SURFACE COMPLETION

At the surface, the wells will have a sufficient amount of casing above ground to accommodate the pump works. The pump works have their own well head assembly that attaches to the casing by a flange that is attached to the well casing. The well head assembly is pre-assembled to accommodate the pump motor assembly and the connections to the product collection system.

On the ground, in the area around the wellhead, a four-foot by four-foot by four-inch thick reinforced concrete pad will be constructed. This pad will serve to protect the casing and to prevent surface water from infiltrating into the well. Depending on the location of the well, four-inch diameter, concrete filled, bumper posts may be installed on each corner of the pad to further protect the wellhead.

A diagram of the well construction is presented as **Figure 2, Generalized Well Construction Diagram.**

5. PUMP DESIGN

During the development of the computer simulation, analyses were made on data collected from hydraulic conductivity tests that indicate that the pumping rates for product recovery will be very low (DSM 1998). During the computer simulation, several pumping rates were tested and a final pumping rate of one-quarter of a gallon per minute was used in the model. At that rate, the model calibrated to the other, fixed parameters and indicated that a substantial amount of the product will be recovered over the predicted period of time. In addition, a low pumping rate is considered essential to prevent a rapid decline in the saturated subsurface product thickness of the formation in the vicinity of the well. Because the saturated thickness of the subsurface product in the formation is approximately 1.5 feet to 2.0 feet, a reduction of only a few inches could result in a dramatic lowering of the transmissivity with a subsequent drastic reduction in recovered product yields to the wells.

Another consideration in the design of a pumping system is the type of power available. Most product recovery pumps operate on compressed air, but at the CORCO Facility the wells are distributed over such a large area that compressed air is not a feasible source of power for the pumps. There is, however, electric power available throughout most of the facility. Therefore, it was determined that electric, very low yield, positive displacement pumps would be the most efficient method of product recovery.

In some cases the recovery pumps will have to overcome more than 230 feet of dynamic head. The very low discharge rates required and the amount of head that must be overcome severely limits the type of pump that can be used. Of the choices available, the Blackhawk, Anchor Pump, Model 101 and Model 102 were chosen. These pumps are positive displacement, electric powered pumps whose motors and drive assemblies are located above ground, at the wellhead. Product is brought to the surface by a drive piston operating inside of a discharge tube, similar to a windmill pump or an oil field "sucker rod pump". The Model 101 pump has an operating range of zero to two gallons per minute and the Model 102 has an operating range of zero to five gallons per minute. The pump will operate wet or dry, so that if the product level is drawn down to below the intake valve, the pump will not shut down. Product recovery will resume when the product level rises again or the depth of the intake is adjusted. This feature will reduce the amount of recovery time that is typically lost because of pump shutdown or failure when suction is broken. In addition, small amounts of suspended solids in the product will not affect the efficiency of the pumps or cause damage to them. Because the

objective of this system is to produce only product, each pump will be fitted with a conductivity probe that will automatically shut off the pump motor if water rises to the intake level. Specifications and operating diagrams for these pumps are shown in **Appendix A - Pump Specifications**.

6. COLLECTION SYSTEM

Each recovery well will be connected to the recovery conveyance/collection piping system that will, in turn, deliver the product to the designated storage tank, Tank 704. The product will accumulate in the storage tank until the quantity of product is sufficient for marine transport and sale.

From each well head the discharge tube will connect to a one-and-one-half (1½) inch diameter, steel collector pipe. This pipe will transfer the product from the well head to larger, main collector lines that will deliver the product to Tank 704, where it will be stored until sold. These lines will be encased in larger steel pipe in areas where damage is likely or could easily occur, such as at road crossings.

Because of the small positive and negative elevation differences between the well heads and the storage tank, no auxiliary pumps will be needed in the collection line system. The primary pumps can easily overcome the friction losses in the pipe, since the flow is primarily gravity driven. In order to prevent a back flow situation in the conveyance system, one-way check valves will be placed at strategic locations in the lines and at each well head.

A schematic drawing of the collection system is shown in **Figure 3, Product Collection System Layout**.

7. OPERATION AND MONITORING

Once the pumps are installed and connected to the collection pipe system, a program of periodic inspection, adjustment, and monitoring of recovery rates will commence. At the same time a periodic inspection for leaks throughout the system will be conducted. The level and thickness of product measured in the wells does not represent the true thickness of product in the formation. The measured thickness in the well is always greater than the true thickness in the formation. As the product in the well is removed, the total thickness in the well will decrease until equilibrium with the formation is reached. Typically, the water level in the well will rise in response to the removal of the product. Therefore, immediately after installation and for some period thereafter, the pumps will have to be adjusted vertically in the well to insure that they are pumping only product. Vertical adjustments of the pump intake level will be made at the well head. The system is designed such that the entire pump string, that is the motor and the pump rods, can be adjusted several inches at the surface, without removing the motor or rods. If the adjustment is more than a few inches, some pump rods may have to be added or removed. Because the objective of this system is to produce only product, each pump will be fitted with a conductivity probe that will automatically shut off the pump motor if it begins to

pump water. The weekly inspection will determine which pumps, if any, have shut down and they will be adjusted to continue pumping product.

Depending on the volume of product being produced, the pumping rates will be adjusted accordingly. The pump motor speed is also adjusted at the well head without having to remove the pump motor or pump rods.

Some of the recovery wells are located next to existing monitoring wells so that the level and thickness of product can be measured without disturbing the pumping. In other wells a measuring port will be installed so that the level and thickness of the product in the well can be measured. In this case, the pump will be turned off for a few minutes prior to making the measurements so that the level can stabilize somewhat. Measurements of product level and thickness will be made using an electric water/product interface probe.

A schedule for the monitoring of the wells and pumps follows is shown in **Table 7-1 Well Monitoring Schedule**.

Table 7-1: Well Monitoring Schedule

Period	Measure Observation/ Pumping Well	Check Sample Port	Record Flow Rate	Adjust Pump Intake Height	Inspect Collection Pipe System	Lubricate Pump Motor
Weekly		X	X			
Monthly	X				X	
As Needed				X		
As Specified						X

CORCO plant personnel will execute this schedule. Data collected by the plant personnel will be transmitted to DSM on a weekly basis for analysis. Recommendations for adjustments to intake levels and pumping rates will be made according to need.

8. IMPLEMENTATION SCHEDULE

Although the actual date for the beginning of construction of this recovery system depends on the date of approval from the U.S. Environmental Protection Agency, it is anticipated that US EPA approval will allow for the implementation of the Recovery System Installation project in December of 1998. A time-line schedule, projecting project implementation in December 1998 is included in this document. This time line schedule includes the installation of the wells, installation of the pumps, construction of the recovery piping system, and start-up of the system. After start-up, the regular monitoring schedule will begin.

The entire, product recovery system installation is projected to take approximately one and one-half (1 1/2) years to complete. The product recovery System installation project is comprised of four interconnected phases as described below:

1. **Phase One** – Preparation and distribution of contracts for drilling, pumps, well materials, and surveyors. This phase will take approximately 1 month to complete. There will then be a 2 month lag in the schedule while the well materials are being manufactured and delivered and the drilling contractor mobilizes.
2. **Phase Two** – Drilling and installation of the recovery wells. It will take approximately 8 months to drill and install the new recovery wells and complete the surface completions.
3. **Phase Three** – Pump installation and testing. Installing and testing the pumps will require approximately 6 months.
4. **Phase Four** – Document preparation. This phase will consist of preparing the as-built drawings, operation and monitoring documents, a project summary report, and developing a monitoring data base to track the effectiveness of the product recovery project. This phase will take approximately 2 months.

The Implementation schedule is in **Appendix B, Recovery System Implementation Schedule**

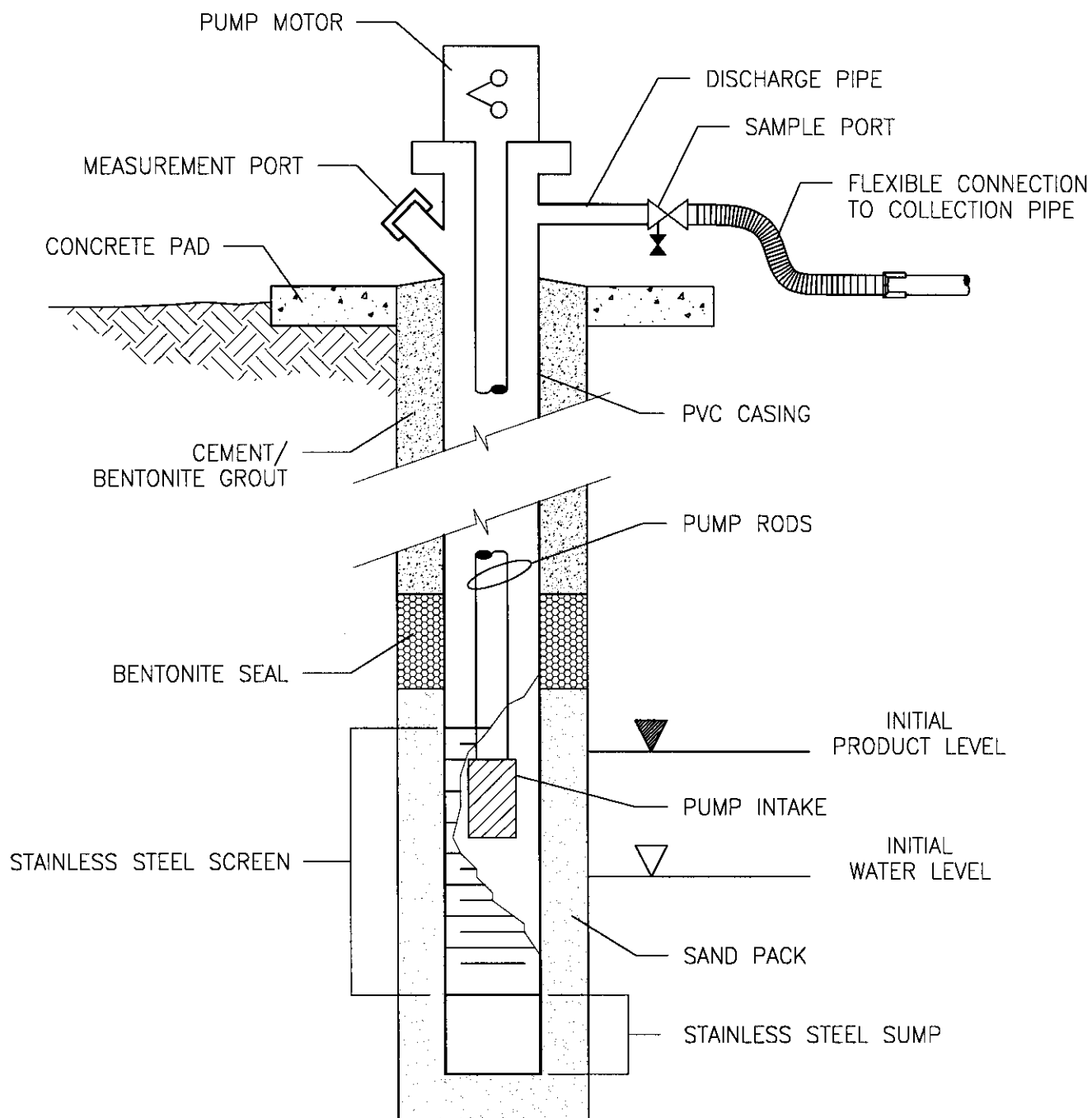
9. REFERENCES

Driscoll, F. G., 1987, *Groundwater and wells*, Second Edition, Johnson Division, St. Paul, MN, 1089 p.

DSM Environmental Services, Inc., 1998, *Phase II -- Subsurface Product Recovery Simulation Report*

Grossman, I. G., Dean B. Bogart, James W. Crooks, and Josè R. Díaz, 1972, *Water Resources of the Tallaboa Valley, Puerto Rico*, United States Geological Survey, Water Resources Bulletin 7.

Kruschensky, R. D. and Monroe, Watson, H., 1978, *Geologic map of the Peñuelas and Punta Cuchara quadrangles, Puerto Rico*, Miscellaneous Investigation Series, Map I - 1042, U.S. Geological Survey.



DSM ENVIRONMENTAL SERVICES, INC.

**CORCO
TYPICAL RECOVERY
WELL CONSTRUCTION**

PROJECT: 1125-01	DRAWN BY: MWH	CHK'D BY:	REV:
DATE: 8/3/98	SCALE: NTS	FIGURE: 2	DB NUMBER:

APPENDIX A

Pump Specifications

B L A C K H A W K
Environmental Company

Offering the perfect pumping solution for groundwater clean-up and product / leachate recovery.



THE ANCHOR PUMPS®

The Blackhawk Anchor Pump® is a positive displacement piston pump. It is powered by a pneumatic or electric top head drive motor. It is made of a stainless steel or corrosion resistant thermo plastic cylinder, self cleaning check-ball assemblies, and a fiberglass sucker drive rod. The Anchor Pump® is made to be a simple pump for difficult applications.

The Anchor Pump® top head drive assembly is situated above the well. It is connected to the cylinder by means of the riser eduction pipe. The up and down motion of the surface head drive motor is transferred to the fiberglass drive rod, which is attached to the inlet drive piston. This motion presses and lifts the liquid being pumped past the bottom intake of the foot valve into the cylinder pump assembly to the surface for discharge.

The Anchor Pump® is designed for shallow or deep well recovery. The Anchor Pump® can operate at vertical or horizontal well angles. The pump can run wet or dry and pulls down liquid to zero submergence. The self cleaning piston drive assembly resists malfunction due to dissolved mineral encrustation, and biological slime.

There Are Three Anchor Pump® Models

	Minimum Well I.D.	Flow Performance*
• Model 101	2" diameter	0 - 2 GPM
• Model 102	3" diameter	0 - 5 GPM
• Model 103	4" diameter	0 - 11 GPM

** Anchor Pumps can be built to pump up to 20 GPM*

TYPICAL SPECIFICATION FOR ANCHOR PUMP® 101

1.0 Scope

- 1.1** The pump shall be designed for wet or dry operation.
- 1.2** The pump shall be able to pump .05 gpm per stroke at 0 submergence.
- 1.3** The pump shall be driven by a top drive head motor assembly at surface grade.
- 1.4** The pump shall be Blackhawk Anchor Pump® model 101 or equal.

2.0 System Capacity and Drive Head Motor Assembly Requirements

- 2.1** The pump shall have the capacity of 2 US GPM when operating at 0 submergence.
- 2.2** The air motor shall be rated for 120 psi., 40 Strokes per min.

3.0 Pump Design and Materials of Construction

- 3.1** There shall be a continuous fiberglass sucker rod assembly to drive the pump.
- 3.2** The pump cylinder, piston, rod connectors and screen shall be stainless steel, and/or Thermoplastic.
- 3.3** The piston shall have seals that resist chemical degradation.
- 3.4** A screen shall be included as part of the suction inlet assembly.
- 3.5** A stuffing box shall be used at surface grade to prevent liquid from entering the drive head motor assembly.
- 3.6** Name plate shall be affixed to the pump head.
The pump model shall be noted on nameplate.

4.0 Pneumatic Drive Head Design

- 4.1** The motor shall be of a pneumatic cylinder design.
- 4.2** The motor shall be able to work with inlet pressure ranging from 30 to 120 psi.
- 4.3** No air from pump drive head motor assembly shall be introduced down the well or come in contact with the liquid being pumped.
- 4.4** The motor shall have a stuffing box at the drive shaft.

5.5 Environmental Requirements

- 5.1** The pump drive head motor assembly at surface grade shall be enclosed in a PVC protective shroud suitable for outdoor installations.

TECHNICAL DATA

Anchor Pump® 101

Flow Range: 0 to 2 US GPM

Discharge Per Stroke: .05 US GPM

Motors: Anchor Pneumatic Motor Standard

Stroke Length: 12"

Maximum Operating Pressure: 120 PSI

Maximum Strokes Per Minute: 40

Variable Speed (Stroke) Control

Overall Length: 18"

MAX DIA.: 8"

Discharge Size: 1 1/4" NPT

Pump End Construction Material: Stainless Steel,
Nitril, Fiberglass, PVC, Delrin.

Installation: Unit can be installed vertically or
horizontally

Pump Cylinder Length: 24"

Riser Pipe: 1 1/4"

Sucker Drive Rod Connection: 7/16 - 20 thread

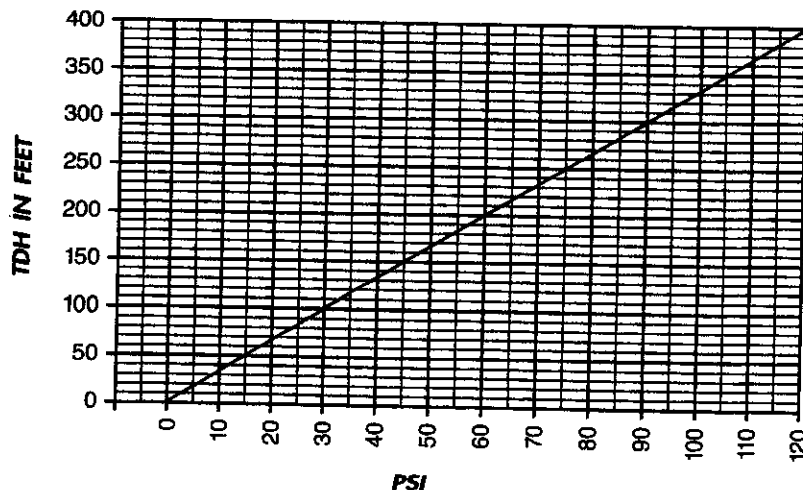
Operational Depth: 500'

Net Weight Air Motor System: 17 LBS.*

Ship Weight: 18 LBS.

*For 10' complete system. Additional 10' Lengths Riser
Pipe & Drive Rod: 5 LBS.

PSI REQUIREMENT FOR VARIOUS DEPTHS USING THE
ANCHOR PUMP® MODEL 101



TYPICAL SPECIFICATION FOR ANCHOR PUMP® 102

1.0 Scope

- 1.1** The pump shall be designed for wet or dry operation.
- 1.2** The pump shall be able to pump .125 gpm per stroke at 0 submergence.
- 1.3** The pump shall be driven by a top drive head motor assembly at surface grade.
- 1.4** The pump shall be Blackhawk Anchor Pump® model 102 or equal.

2.0 System Capacity and Drive Head Motor Assembly Requirements

- 2.1** The pump shall have the capacity of 5 US GPM when operating at 0 submergence.
- 2.2** The drive head shall be rated for 120 psi., 40 Strokes per min.

3.0 Pump Design and Materials of Construction

- 3.1** There shall be a continuous fiberglass sucker rod assembly to drive the pump.
- 3.2** The pump cylinder, piston, rod connectors and screen shall be stainless steel and/or thermoplastic.
- 3.3** The piston shall have seals that resist chemical degradation.
- 3.4** A screen shall be included as part of the suction inlet assembly.
- 3.5** A stuffing box shall be used at surface grade to prevent liquid from entering the drive head motor assembly.
- 3.6** Name plate shall be affixed to the pump head.
The pump model shall be noted on nameplate.

4.0 Pneumatic Drive Head Design

- 4.1** The motor shall be of a pneumatic cylinder design.
- 4.2** The motor shall be able to work with inlet pressure ranging from 30 to 120 psi.
- 4.3** No air from pump drive head motor assembly shall be introduced down the well or come in contact with the liquid being pumped.
- 4.4** The motor shall have a stuffing box at the drive shaft.

5.5 Environmental Requirements

- 5.1** The pump drive head motor assembly at surface grade shall be enclosed in a PVC protective shroud suitable for outdoor installations.

TECHNICAL DATA

Anchor Pump® 102

Flow Range: 0 to 5 US GPM

Discharge Per Stroke: .125 US GPM

Motors: Anchor Pneumatic Motor Standard

Stroke Length: 12"

Maximum Operating Pressure: 120 PSI

Maximum Strokes Per Minute: 40

Variable Speed (Stroke) Control

Overall Length: 18"

MAX DIA.: 8"

Discharge Size: 1 1/4" NPT

Pump End Construction Material: Stainless Steel,
Nitril, Fiberglass, PVC, Delrin.

Installation: Unit can be installed vertically or
horizontally

Pump Cylinder Length: 24"

Riser Pipe: 2"

Sucker Drive Rod Connection: 7/16-20 thread

Operational Depth: 100'

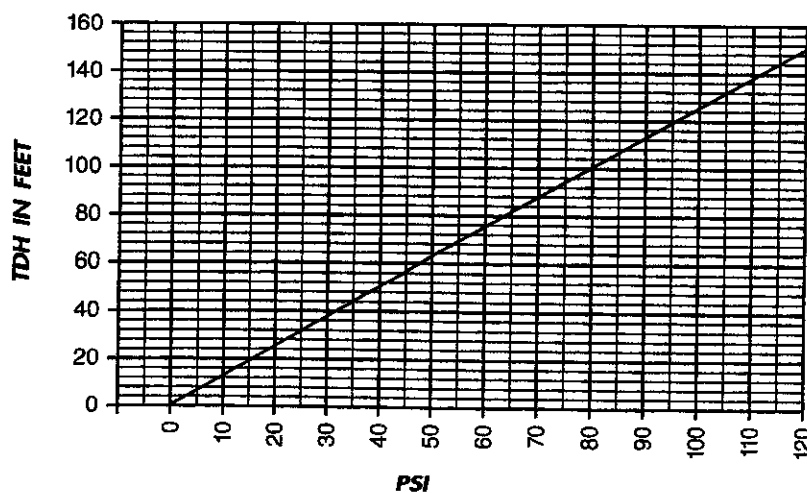
Net Weight Air Motor System: 22 LBS.

Ship Weight: 25 LBS.

For 10' complete system. Additional 10' Lengths Riser
Pipe & Drive Rod: 7 LBS.



PSI REQUIREMENT FOR VARIOUS DEPTHS USING THE
ANCHOR PUMP® MODEL 102



1. Well Construction

[illegible]

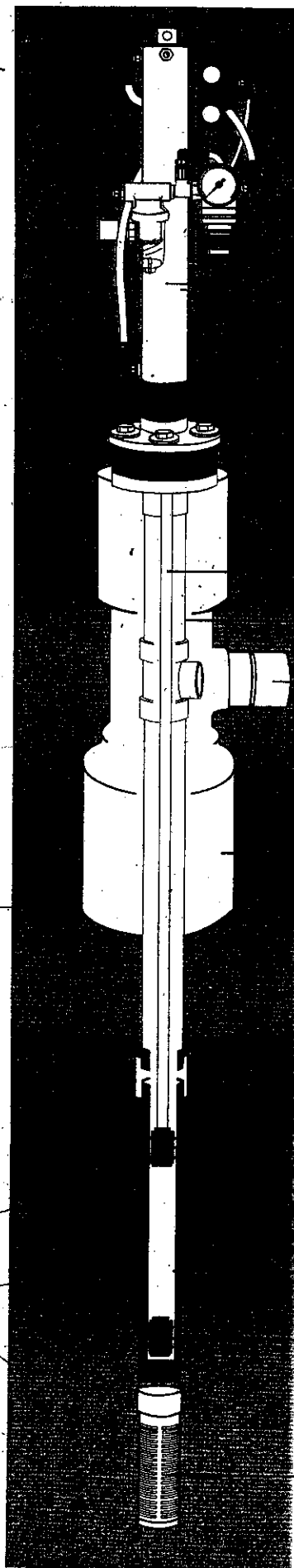
_____ gpm
_____ psi
_____ ft.

_____ F.

[illegible]

_____ psi





Top Head Drive Motor
Control Assembly

Stuffing Box

Well Head Cap

Drive Rod

Riser Pipe

Discharge Tee

Well Casing

Ground

Drive Piston

Fluid

Pump Cylinder

Foot Valve

Inlet Screen

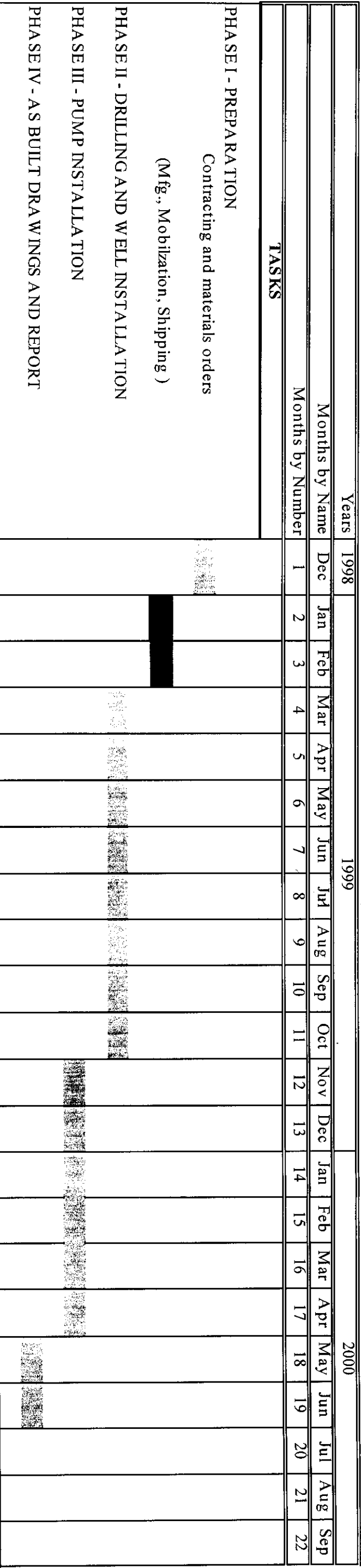


APPENDIX B

Recovery System Implementation Schedule

APPENDIX B

RECOVERY SYSTEM INSTALLATION SCHEDULE



DSM

ENVIRONMENTAL SERVICES, INC.

CORCO

RECOVERY SYSTEM
INSTALLATION SCHEDULE

PROJECT: 1125-01

DRAWN BY: MWH

CHK'D BY:

REV:

DATE: 8/4/98

SCALE: NTS

FIGURE:

DB NUMBER: